

Final Technical Report

NASA (*FUSE*) Grant: NAG5-10324

Title: The Physical Character of Small-Scale Interstellar Structures

Program ID: B046 (Cycle 2)

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The primary objective of this program was to obtain *FUSE* observations of the multiple interstellar absorption lines of H_2 toward the members of 3 resolvable binary/multiple star systems to explore the physical conditions in known interstellar small-scale structures. Each of the selected systems was meant to address a different aspect of the models for the origin of these structures:

- 1) the stars HD 32039/40 were meant to probe a temporally varying component which probed a cloud with an inferred size of tens to a few hundreds of AU. The goal was to see if there was any significant H_2 associated with this component.
- 2) the star HD 36408B and its companion HD 36408A (observed as part of *FUSE* GTO program P119) show significant spatial and temporal (proper motion induced) Na I column variations in a strong, relatively isolated component, as well as a relatively simple component structure. The key goal here was to identify any differences in H_2 or C I excitation between the sightlines, and to measure the physical conditions (primarily density and temperature) in the temporally varying component.
- 3) The stars HD 206267C and HD 206267D are highly reddened sightlines which showed significant variations in K I and molecular absorption lines in multiple velocity components. Coupled with *FUSE* GTO observations of HD 206267A (program P116), the goal was to study the variations in H_2 along sightlines which are significantly more distant, with larger separations, and with greater extinctions than the other selected binary systems.

Observations for this program were carried out between January 6th, 2001 and June 30th, 2002. Unfortunately due to *FUSE* reaction wheel problems we were unable to obtain the planned observations of HD 36408B, and instead substituted additional observations of HD 206267A. The results of these observations was somewhat mixed, with no significant H_2 being detected toward HD 32039/40 (at odds with some theoretical suggestions). These results are being combined with our recently obtained *HST* observations of the HD 32040 sightline for publication purposes. The submission for publication of the combined *HST* and *FUSE* analysis is expected sometime in 2005.

Unlike HD 32039/40, copious H_2 was detected toward all three stars in the HD 206267 system, and the analysis of this data formed the basis for the senior honors thesis of Matthew Turk at Northwestern University (June 2003). These results suggested that while there was little difference in the total H_2 column toward these stars, there were some differences in the

H₂ excitation along these sightlines. A preliminary draft of an *Astrophysical Journal* article discussing these results (as well as the results of our supporting ground-based observations) was begun, but failed to be completed due to the demands of graduate school on Matt's time. After much discussion the responsibility for the preparation of the final manuscript was moved back to Northwestern University in the Fall of 2004, and is currently on-going.